Bi/CNS/NB 150: Neuroscience

Lecture 2

Wednesday Sept. 30, 2015

Anatomy

First Discussion section

Tomorrow (Thursday)

We emphasize these points from Kandel in Bi/CNS 150

Read			Lecture
1: pp 5-10	Introduction	Brains evolved All higher animals have brains Neurons across species look remarkably similar How these neurons are connected differs A hallmark of brains is complexity Human brains are large and wrinkly and have large frontal cortex	Sept 28 (today)
15: 337-344	Anatomy	The nervous system can be subdivided into regions The brain is a tube The brain floats in your skull NS = PNS + CNS ANS = PNS + CNS = sympathetic + parasympathetic Sensorimotor cortices are topographically organized	Sept 30 (Weds)
	Discussion section	Real human brains	Oct 1 (Thurs)
52: 1165-1185 53: 1187-1194 53: 1218-1227	Development	Most of the complexity of the brain comes from development It is impossible to create an adult human brain without development There are relatively simple developmental rules Development = genes + environment	Oct 2 (Fri)

Overview, comparisons, evolution
Terms
Gross structure
Spatial orientation
Major pathways
Parts of Cortex
Methods

The Human Brain in Perspective

~20,000 protein-coding genes in the genome
>100,000 distinct neuronal phenotypes
ca. 85 B neurons
ca. 10^14 connections
astronomical number of ensembles
unbounded number of mental states?

20,000-30,000 neurons per mm3
4 km axons per mm3
2-4 mm cortical thickness
ca. 10^9 synapses under mm2

Information is encoded in the wiring of the brain.

This depends in large part on experience.

Human brains are unusually large.

-adult human brains are unusually large
-newborn human brains are unusually small
-humans are very altricial (the opposite of precocious)

Noteworthy inventions:

--myelin: vertebrates

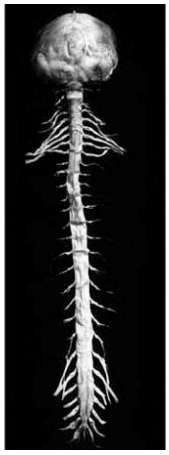
--neocortex: mammals

--corpus callosum: placental mammals

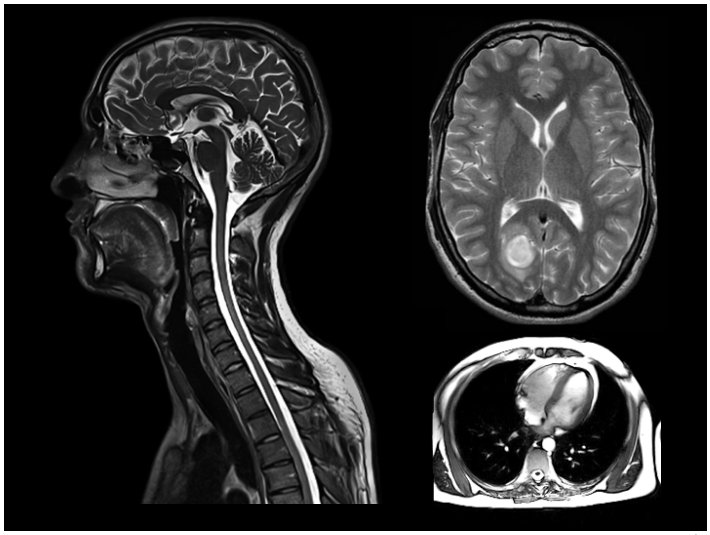
--large prefrontal cortex: primates

--mirror neurons: primates

--Von Economo neurons: apes



1. Foramen magnum level
2. Brachial plexus
3. 1st thoracic nerve
4. 1st lumbar spinal ganglion
5. 1st sacral nerve
6. Filum terminale



CNS

Central Nervous System

PNS

Peripheral Nervous System

Afferent (vs. Efferent)

Input (output) to (from) a certain structure

Efferent

Fibers that carry output from a certain structure

ANS

Autonomic Nervous System

= Central + Peripheral Components

Efferents to smooth muscle, organs

Afferents from cranial nerves (Vagus) and spinal

Peripheral Nervous System

White matter

Made up of Myelinated Axons (which are white)

Gray Matter

Made up of cell bodies of neurons

Myelin

Fatty substance derived from oligodendrocytes or Schwann cells that surrounds axons

For saltatory conduction of action potentials

Ganglion (ganglia)

Group of cell bodies found in the PNS

Nucleus (nuclei)

Group of cell bodies found in the CNS (not the same as a cell nucleus)

Nerve

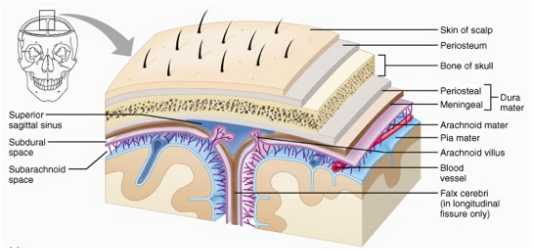
Bundle of axons found in the PNS (vs. **Tract**).

Sulcus (sulci)

Inward groove or valley between two gyri on the cortex

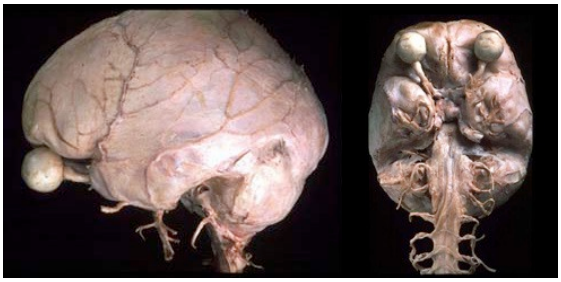
Gyrus (gyri)

Outward fold or hill on either side of a sulcus



Meninges and Ventricles

Dura Mater



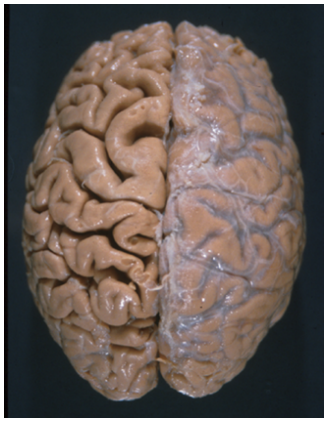
•Surrounds brain, closely adherent to skull (no epidural space)

•Two fused layers (periosteal and meningeal) which split to form venous sinuses.

•Thick and leather-like, contains pain receptors (none in arachnoid, pia, or brain)

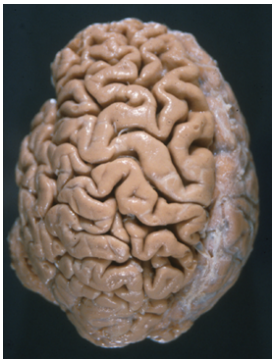
Arachnoid

- **Closely associated with brain and dura (no subdural space).**
- **Subarachnoid space where CSF and Blood Vessels live**
- **Does not follow surface of brain into sulci**
- **Forms arachnoid granulations on the dorsal surface**

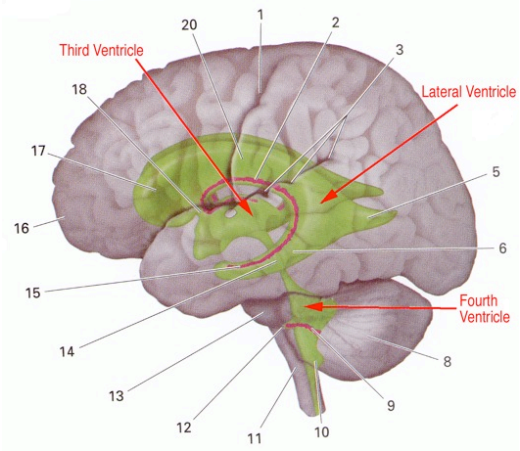


Pia Mater

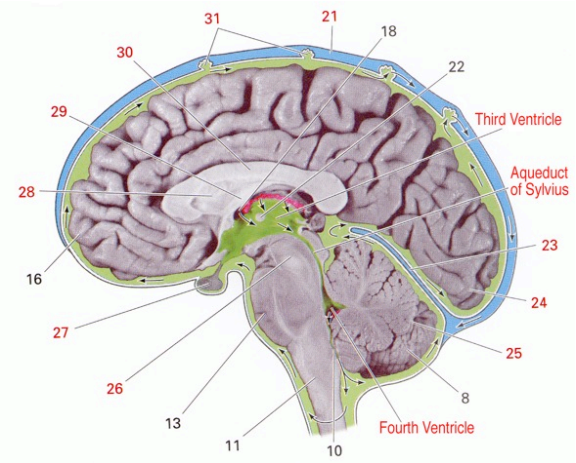
- **Closely adherent to surface of the brain**
- **Cannot be separated without destroying cortical surface**
- **Follows vessels as they pierce the cortex**

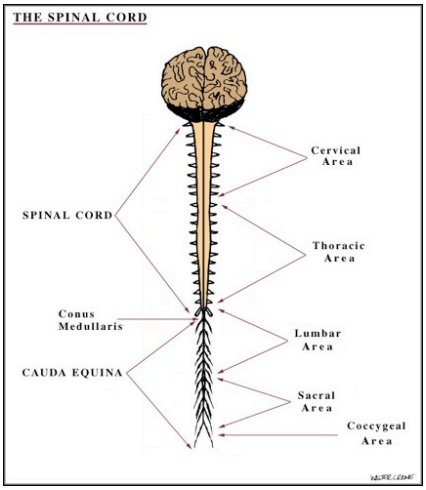


Ventricles

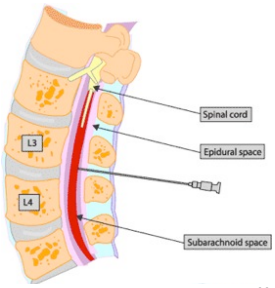


Flow of Cerebrospinal Fluid

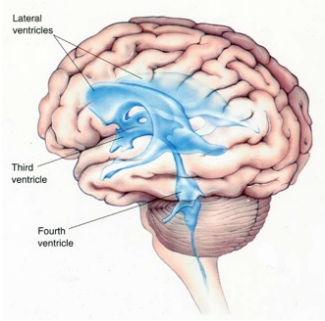


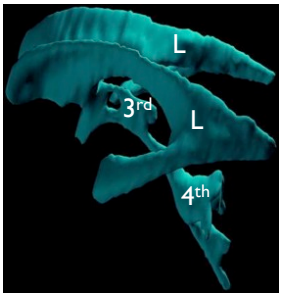


lumbar puncture
aka "spinal tap"

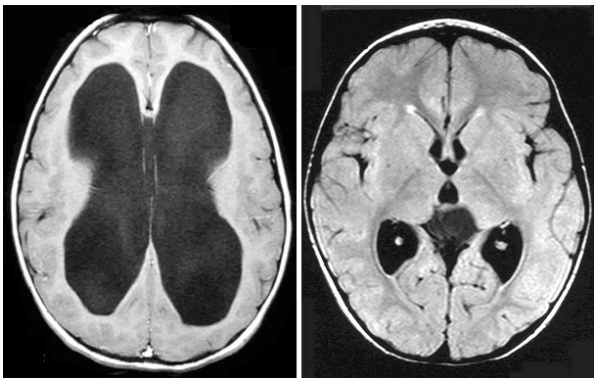


Cerebral Ventricles



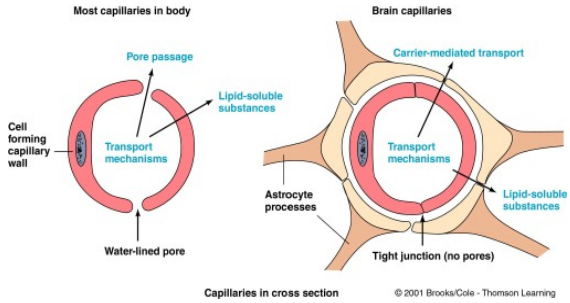


Hydrocephalus

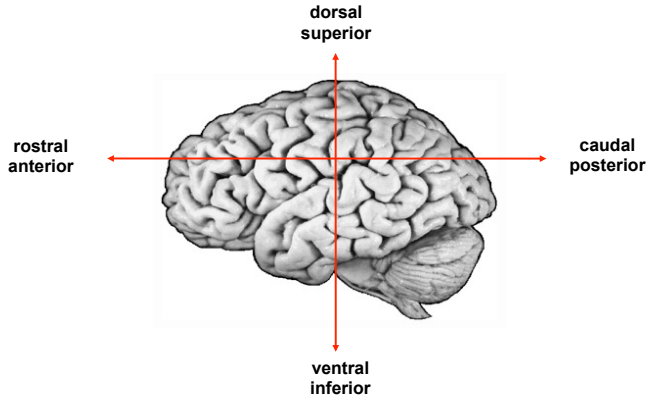


There is a blood-brain barrier

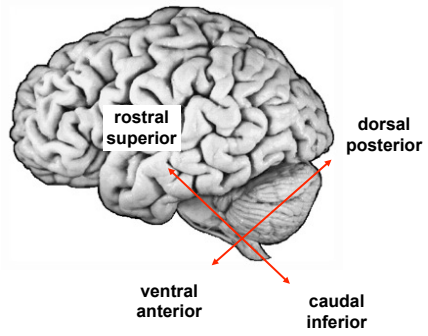
-prevents large molecules from passing through
-tight junctions in blood vessels
-separation of CFS from blood

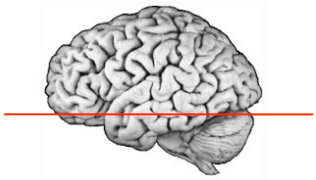


Orientation

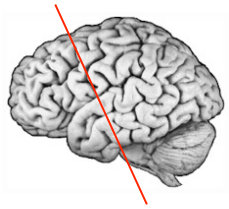


the brain takes a turn at the cephalic flexure

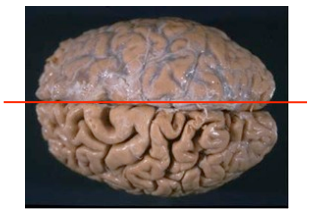




Horizontal cut
Has symmetry (mirror images)
Long (oval)

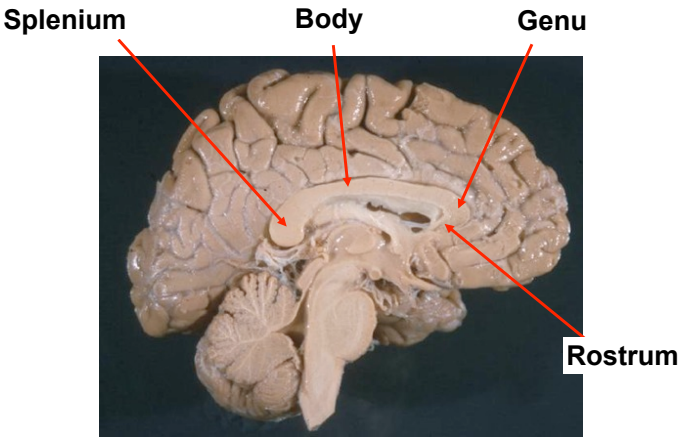


Coronal cut
Has symmetry (mirror images)
round (circle-sort of)



Sagittal cut
Does not have symmetry

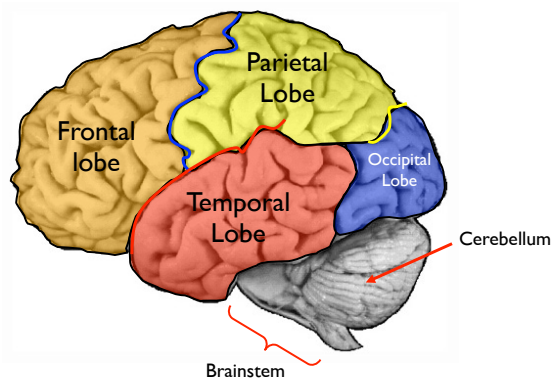
The Corpus Callosum

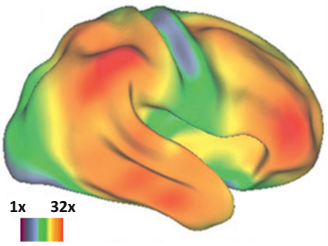


Inputs and Outputs of the CNS

12 Cranial Nerves:

1. Olfactory	Smell
2. Optic	Sight
3: Oculomotor	
6: Abducens	Eye movements
4: Trochlear	
5: Trigeminal	Touch/Pain
8: Auditory/ Vestibular	Hearing/ balance
10. Vagus	Autonomic





Amount of Macaque brain expansion needed to fit a monkey brain to a human brain

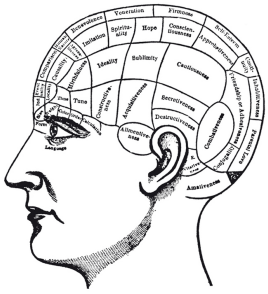
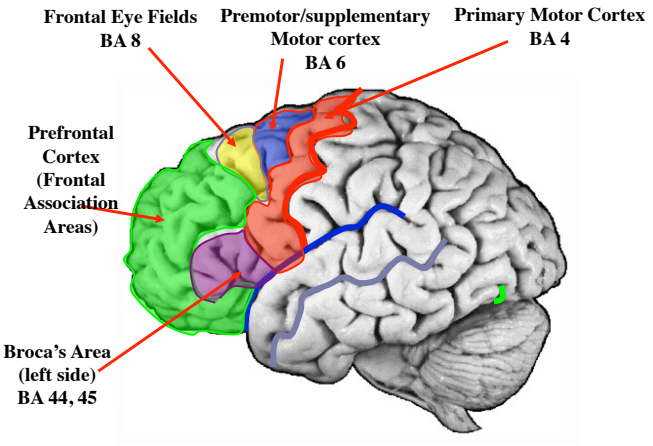
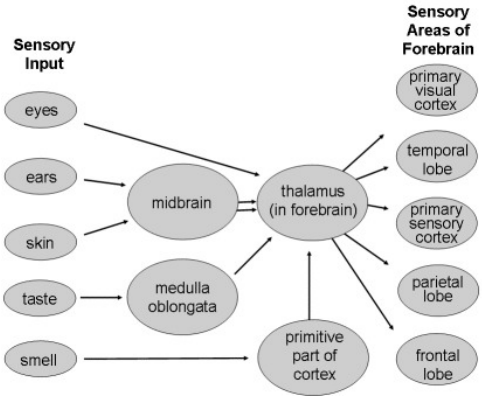


Figure 1–1 **An early map of functional localization in the brain.** According to the 19th century doctrine of phrenology, complex traits such as combativeness, spirituality, hope, and conscientiousness are controlled by specific areas in the brain, which expand as the traits develop. This enlargement of local areas of the brain was thought to produce characteristic bumps and ridges on the overlying skull, from which an individual's character could be determined. This map, taken from a drawing of the early 1800s, purports to show 42 intellectual and emotional faculties in distinct areas of the skull and the cerebral cortex underneath.





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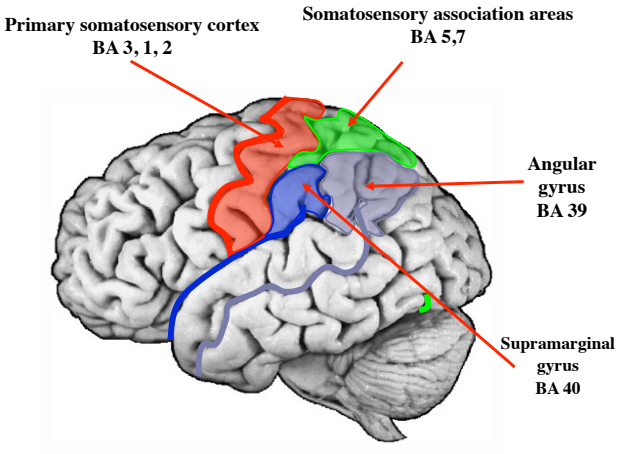
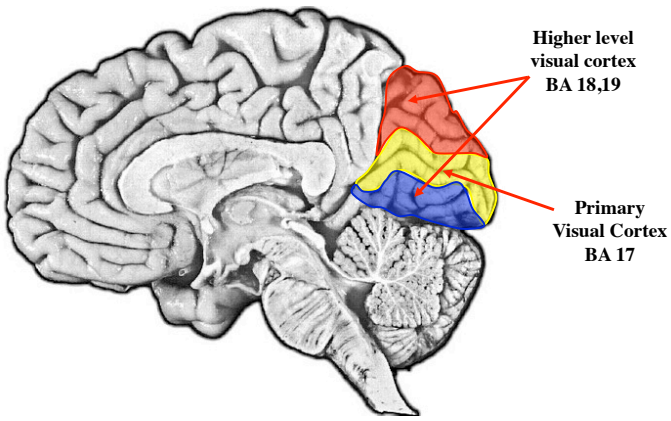
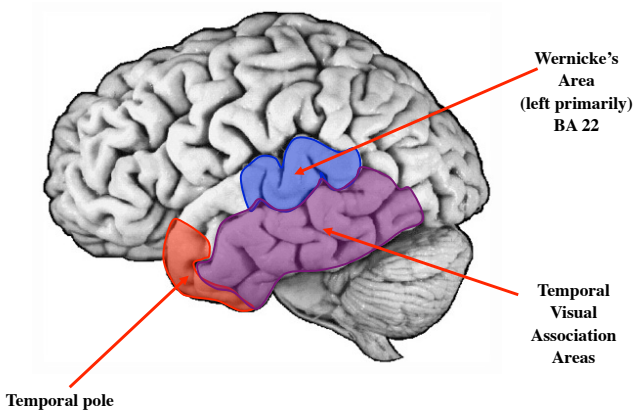
All sensory input goes through the thalamus
-exception: olfaction

All cortex receives thalamic inputs
-possible exception: frontopolar cortex





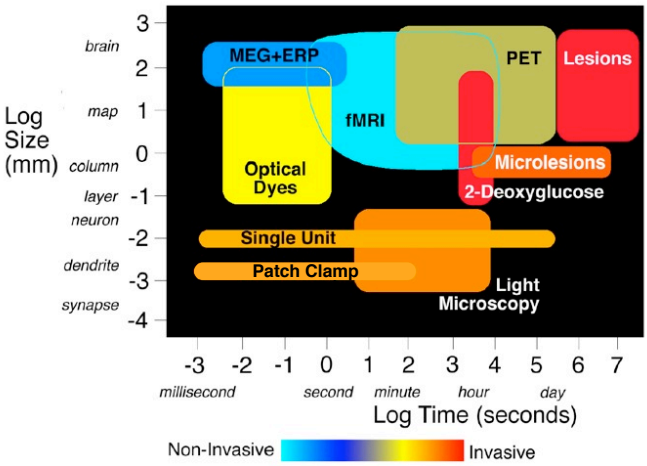


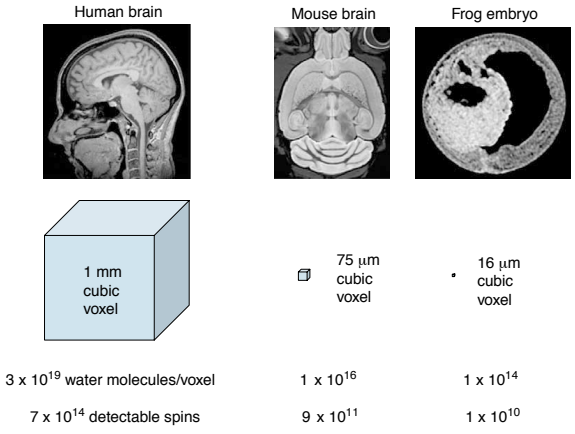
Neocortex is organized into maps

-primary sensory cortices are topographic
-higher-order cortices are next to primary cortices
-there are information processing streams through cortex

Summary of basic principles

1. inputs/outputs are contralaterally organized
2. functional specialization in anatomical regions
3. hemispheric asymmetry in function
4. there are functional and anatomical pathways
5. there is massive feedback
6. terms: parallel, serial, digital, analog, convergence, divergence, hierarchy





....there could be a quiz next time.....